Bomb Bags

Introduction to The Mole Concept

Introduction

Investigate the chemical contents in a popular toy to find out what makes it pop!

Concepts

- Acids and bases
- Indicators
- Scientific method
- pH

Materials

Toy "Bomb Bag™"
Citric acid, $C_6H_8O_7$, 1 g
Rainbow indicator solution, pipet full
Sodium bicarbonate, $NaHCO_3$, 1 g
Universal indicator solution, pipet full
Water, distilled, 5 mL
Balance, 1.0-g precision
Cup or beaker, small
Graduated cylinder, 10-mL
Microspatula
Paper towels
Pipets, 4
Scissors
Spot plate
Toothpicks, 3
Weighing dishes, 3

Safety Precautions

Citric acid, sodium bicarbonate, and the contents of the toy Bomb Bag may be irritating to tissue, and especially irritating to the eyes. Indicator solutions may stain skin and clothes. Avoid contact of all chemicals with eyes and skin. Follow all laboratory safety guidelines. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information. Wash hands thoroughly with soap and water before leaving the laboratory.

Procedure

1. Shake the contents of the toy down to the bottom of the bag.
2. Carefully cut off a top corner of the foil bag using scissors.
3. With a gloved hand, pull out the "magic water " pouch from inside the bag.
4. Set the bag on a sheet of paper towel and set aside.
5. Place the weighing dish on the balance. Zero the balance.
6. Shake the remaining solid from inside the bag onto the weighing dish.
7. Record the mass of the unknown solid (to the nearest tenth of a gram) in the Data Table.
8. Using scissors, carefully cut off a corner of the "magic water" pouch and pour the contents into a 10-mL graduated cylinder. Squeeze the packet to get as much of the liquid out as possible. Record the volume (to the nearest tenth of a mL) in the Data Table.

Note: Refer to Figure 1 for steps 9–24

9. Weigh out 1 g of citric acid in a weighing dish.
10. Weigh out 1 g of sodium bicarbonate in a weighing dish.
11. Using a pipet, dispense 10 drops of "magic water" from the graduated cylinder (step 8) into wells 1 and 2, and 2 drops

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of the magic water to well 11 of the spot plate.

12. Obtain approximately 5 mL of distilled water in a cup or beaker.
13. Using a clean pipet, add 10 drops of distilled water to wells 3–12 on the spot plate.
14. Using a microspatula, add an overflowing scoop of the unknown solid to wells 3 and 4 on the spot plate. Stir with a toothpick. Rinse the microspatula thoroughly with water.
15. Using a fresh microspatula, add an overflowing scoop of citric acid to wells 5, 6, and 12 on the spot plate. Stir with a fresh toothpick. Rinse the microspatula thoroughly with water.
16. Using a clean microspatula, add an overflowing scoop of sodium bicarbonate to both wells 7 and 8. Stir with a fresh toothpick. Rinse the microspatula thoroughly with water.

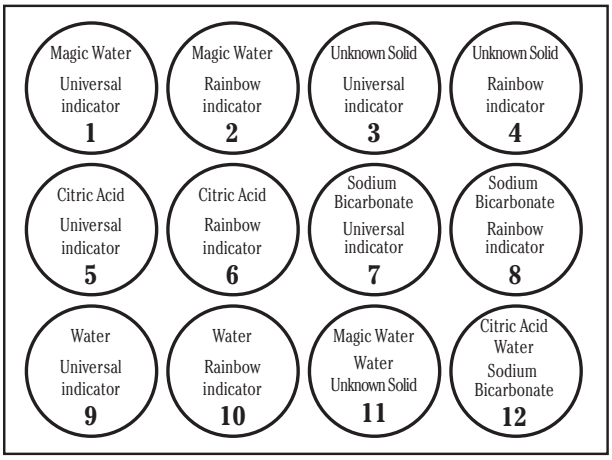

Figure 1.

17. Using a fresh pipet, add two drops of universal indicator to wells 1, 3, 5, 7, and 9. Do NOT touch the solutions with the pipet tip when adding the indicator.
18. Using a fresh pipet, add two drops of rainbow indicator to wells 2, 4, 6, 8, and 10. Again, do NOT touch the solutions with the pipet tip when adding the indicator.
19. In the Data Table, record the color of each well.
20. Well 11 contains a water and "magic water" mixture. Add an overflowing scoop of the unknown solid using a clean microspatula. Record observations on the Data Table.
21. Well 12 contains a water and citric acid mixture. Add an overflowing scoop of sodium bicarbonate using a clean microspatula. Record observations on the Data Table.
22. Add two drops of universal indicator to well 11.
23. Add two drops of rainbow indicator to well 12.
24. Record color changes for wells 10 and 11 in the Data Table.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The solutions in the spot plate may be flushed down the drain with excess water according to Flinn Suggested Disposal Method #26b.

Student Data Table

Bomb Bags

Weight of unknown solid _____ g

Volume of "magic water" _____ mL

Well	1	2	3	4	5	6	7	8	9	10
Color										

Well 11

a. Observations —
b. Universal indicator color —
c. pH —

Well 12

a. Observations —
b. Rainbow indicator color —
c. pH —

Post-Lab Questions

1. What was the purpose of using two different indicators in this lab? *Hint:* See the pH color charts below for the indicators.

2. Use the following keys to fill in the pH values for the 10 wells in the table below.

Universal indicator — Wells 1, 3, 5, 7, and 9

pH	≤4	5	6	7	8	9	10
Color	red	orange	yellow	green	green-blue	blue	purple

Rainbow indicator — Wells 2, 4, 6, 8, and 10

pH	1	2	3	4	5	6	≥7
Color	red	orange	yellow	pale green	forest green	green-blue	blue

Well	1	2	3	4	5	6	7	8	9	10
pH										

3. Did you notice any trends or patterns for the pH values in the wells?

4. What purpose did wells 9 and 10 serve, which only contained water and indicator?

5. Based on the indicator color changes in wells 1–10, what chemical appears to be present in the "magic water" solution?

6. Is the pH of unknown solid acidic or basic? Identify the solid based on the results of other wells.

Teacher's Notes

Bomb Bags

Materials *(for a class of 30 students working in pairs)*

Toy Bomb Bags, 17
Citric acid, 100 g
Rainbow indicator, 30 mL
Sodium bicarbonate, 100 g
Universal indicator, 30 mL
Microspatulas, 16
Pipets, 60
Toothpicks, 75
Weighing dishes, 45

Additional Materials Needed *(for each lab group)*

Water, distilled, 75 mL
Balances
Cups or beakers, small, 15
Graduated cylinders, 10-mL, 15
Paper towels
Scissors
Spot plates, 15

Pre-Lab Preparation

Some manufacturers list the chemical contents of the toy on the back of the package. Look at the backs of the bags to see if the ingredients are listed. If they are, black out the print using a fine-tip black permanent marker or a strip of electrical tape.

Safety Precautions

Wear goggles and instruct students to wear goggles during the Pre-Lab activity. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Remind students to wash their hands thoroughly with soap and water before leaving the laboratory. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Disposal

The contents of the spot plate may be flushed down the drain with excess water of according to Flinn Suggested Disposal Method #26b. Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory wastes.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter, chemical reactions, interactions of energy and matter.

Lab Hints

- The Exploring a Chemical Reaction in a Toy—Student Laboratory Kit (Catalog No. AP7048) is available from Flinn Scientific and contains materials for 30 students working in pairs. Two toys are supplied for use as a demo to be done before starting the lab to familiarize students with the toys. Activate the bag by locating the water pouch inside the bag and squeezing it until it breaks. Give the bag a quick shake, drop it in a sink or bucket, and step back and wait for it to pop! Both parts of this laboratory activity may reasonably be completed in one 50-minute class period. The data compilation and *Post-Lab Questions* may be completed the day after the lab. Please reference additional materials needed in *Teacher's Notes*.
- Toy "Bomb Bags" are simple, harmless toys containing small amounts of two household chemicals. They do not pose any danger or threat and cannot be "scaled up" to create potentially dangerous devices.
- Place the universal and rainbow indicator in a central location in the classroom since all students will need access to them. You may wish to remove the "dropper top" for easier pipet access. Alternatively, fill 15 pipets with universal indicator and 15 pipets with rainbow indicator prior to the lab period and place them bulb down (tip towards the ceiling) at each lab station.
- For an advanced chemistry class, you may allow students to design their own procedure for determining the contents of the toy.
- The back of the toy mentions noticing a "fragrance" after the bag pops. A fragrance was not noticed during our testing.

Teaching Tip

- The "magic water" solution is simply a small pouch containing an aqueous solution of citric acid. The volume varies from 2.5 to 4 mL. The solid material in the toy is sodium bicarbonate, typically around 3 g. When pressure is applied to the pouch containing the citric acid, it breaks and therefore allows the citric acid solution to react with the sodium bicarbonate solid. Carbon dioxide is a byproduct of the following reaction:

  $3NaHCO_3 + H_3C_6H_5O_7 \rightarrow 3H_2O + 3CO_2 + Na_3C_6H_5O_7$

  When the volume of carbon dioxide gas produced in this reaction exceeds the volume of the bag, it pops.

Sample Data

Weight of unknown solid _____ g

Volume of "magic water" _____ mL

Well	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Color	*red*	*red-orange*	*green-blue*	*dark blue*	*red*	*orange-red*	*green-blue*	*dark blue*	*green*	*green-blue*

Well 11

a. Observations — *Evidence of chemical reaction—bubbling, foaming, frothing*
b. Universal indicator color — *Green*
c.pH — 7

Well 12

a. Observations — *Evidence of chemical reaction—bubbling, foaming, frothing*
b. Rainbow indicator color — *Green*
c.pH — 7

Post-Lab Questions

1. What was the purpose of using two different indicators in this lab? *Hint:* See the pH charts below.

   Universal indicator has a pH range of 4–10, whereas rainbow indicator has a pH range of 1–7 . Samples with a pH lower than 4 do not give an accurate reading using universal indicator. Rainbow indicator must be used to find actual pH of acidic solution. 2. Use the following keys to fill in the pH values for well 10 in the table below.

   Universal indicator — Wells 1, 3, 5, 7, and 9

pH	**≤4**	**5**	**6**	**7**	**8**	**9**	**10**
Color	red	orange	yellow	green	green-blue	blue	purple

   Rainbow indicator — Wells 2, 4, 6, 8, and 10

pH	**1**	**2**	**3**	**4**	**5**	**6**	**≥7**
Color	red	orange	yellow	pale green	forest green	green- blue	blue

Well	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
pH	*≤4*	*1.2*	*8*	≥7	*≤4*	*1.2*	*8*	≥7	7	*6–7*

3. Did you notice any trends or patterns for the pH values in the wells?

   Well 2, magic water and rainbow indicator; and well 6, citric acid and rainbow indicator; also, well 3, unknown solid and universal indicator; and well 7, sodium bicarbonate and universal indicator appeared to have the same pH.

4. What purpose did wells 9 and 10 serve, which only contained water and indicator?

   These wells served as a control. Since all of the wells contain water, having a well with only indicator and water shows that water has a neutral pH around 7.

5. Based on the indicator color changes in wells 1–10, what chemical appears to be present in the "magic water" solution?

   The color changes and pH values for the magic water solution were very similar to citric acid. The magic water solution probably contains citric acid.

6. Is the pH of unknown solid acidic or basic? Identify the solid based on the results of other wells.

   The unknown solid was basic. Sodium bicarbonate was also basic with a pH around 8.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Bomb Bags* activity, presented by Kathleen Dombrink, is available in *Introduction to The Mole Concept*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Bomb Bags* are available from Flinn Scientific, Inc.

Materials required to perform this activity are available in the *Exploring a Chemical Reaction in a Toy—Student Laboratory Kit* available from Flinn Scientific. Materials may also be purchased separately.

Catalog No.	**Description**
AP7048	Exploring a Chemical Reaction in a Toy—Student Laboratory Kit
AP6399	Spot Plates, Polystyrene, Pkg/12
C0135	Citric Acid, 100 g
S0042	Sodium Bicarbonate, 500 g

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.